2533872

Rec'd PCT/PTO 05 MAY 2005

#2

PCT/CA 03/01686

02 DECEMBER 2003 02-12-03

Office de la propriété intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An Agency of Industry Canada

Bureau canadien des brevets

Certification

Canadian Patent Office

Certification

REC'D 19 DEC 2003
WIPO PCT

La présente atteste que les documents ci-joints, dont la liste figure ci-dessous, sont des copies authentiques des documents déposés au Bureau des brevets.

This is to certify that the documents attached hereto and identified below are true copies of the documents on file in the Patent Office.

Specification and Drawings, as originally filed, with Application for Patent Serial No: **2,411,203**, on November 5, 2002, by **ALPHAGLOBAL IT INC.**, assignee of Joseph Kurian, Hue Tran, William Melek, Afshan Zahedi, Saeed Ziaee and Homayoun Najjaran, for "Intelligent Data Management System and Method".

PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

Agent certificateur/Certifying Officer

December 2, 2003
Date

Canada

(CIPO 68)
04-09-02

OPIC CIPO

Abstract of the Invention

An intelligent data management system and method are disclosed. The system includes a database of stored data, a middleware layer having access to the stored data, and at least one client device for remotely accessing a provided course of action. The middleware layer includes a fuzzy logic knowledge base for generating, updating, or firing fuzzy logic rules and a fuzzy logic inference engine for processing the stored data guided by the fuzzy logic rules to provide the course of action.

Intelligent Data Management System And Method

Field of the Invention

The present invention relates generally to electronic databases, and more particularly to a data management system and method.

Background of the Invention

As far back as 1873, Florence Nightingale lamented her inability to obtain value from paper medical records. Today, faced with an increasingly mobile population, global accessibility to healthcare information is becoming increasingly essential. Early electronic approaches tended to apply industrial engineering concepts to understanding and automating the flow of healthcare, with the expectant failures.

It has been envisioned that the future patient record will be that of a multimedia record capable of including free text, high-resolution images, sound, and full-motion video. These systems, which have come to be known as computer-based patient record (CPR) systems, will be expected to offer improved access, quality, security, flexibility, connectivity, and efficiency.

CPR systems maintain patient records such as histories, reports, charts, and images in digitized form within a networked system of one or more health care institutions. This enables authorized users to access the records remotely employing client devices such as desktop computers, laptops, PDA's (personal digital assistants) and the like coupled to the networked system via wired and/or wireless network paths. The problem is that no patient-centered database exists that provides the medical professional with a comprehensive set of fields for all disciplines of medicine.

Although the human brain excels in its ability to perceive, reason, make decisions and act, it is limited in its ability to handle millions of data elements at the same time. What is needed is a solution that incorporates intelligent systems using the latest technologies to facilitate treatment and diagnosis in an efficient and effective manner.

A knowledge base is a machine-readable resource for the dissemination of information, generally online or with the capacity to be put online. An integral component of knowledge management systems, a knowledge base is used to optimize information collection, organization, and retrieval for an organization, or for the public at large. A well-organized knowledge base can save an enterprise a considerable amount of money by decreasing the amount of employee time spent trying to find information about such topics as tax laws, or company policies and procedures. A knowledge base can give users easy access to information that would otherwise require laborious contact with many people.

In general, a knowledge base is not a static collection of information, but a dynamic resource that may itself have the capacity to "learn", as part of an artificial intelligence (AI) expert system for example. An expert system is a computer application that performs a task that would otherwise be performed by a human expert. For example, there are expert systems that can make financial forecasts or schedule routes for delivery vehicles. Some expert systems are designed to take the place of human experts, while others are designed to aid them. To design an expert system, a knowledge engineer studies how human experts in a particular field make decisions. They then create rules that are subsequently translated into terms that a computer can understand.

The problem is that existing knowledge bases are so inherently tied to their inference engines that they lack flexibility. Traditionally, within knowledge bases the tool of choice has been the "IF_THEN" conditional statement. A basic IF-THEN statement is used when the choice is whether to take an action or not; there is no alternative action. This statement provides direction

only when a parameter is found to be true. The condition in an IF-THEN statement is considered true if its value is non-zero, and false if its value is zero. The problem is that IF-THEN statements are too rigid. What is needed is a system that utilizes a more flexible query logic that can better emulate the superior reasoning processes of a human.

Fuzzy logic is a type of logic that recognizes more than simple true and false values. With fuzzy logic, propositions can be represented with degrees of truthfulness and falsehood. For example, the statement, today is sunny, might be 100% true if there are no clouds, 80% true if there are a few clouds, 50% true if it's hazy and 0% true if it rains all day. One example of the use of fuzzy logic is that of spell checkers, which suggest a list of probable words to replace a misspelled one. It would be advantageous to provide a system that takes advantage of the flexibility of fuzzy logic.

For the foregoing reasons, there is a need for an improved system and method for the management of medical records.

Summary of the Invention

The present invention is directed to an intelligent data management system and method. The system includes a database of stored data, a middleware layer having access to the stored data, and at least one client device for remotely accessing a provided course of action. The middleware layer includes a fuzzy logic knowledge base for generating, updating, or firing fuzzy logic rules and a fuzzy logic inference engine for processing the stored data guided by the fuzzy logic rules to provide the course of action.

In an aspect of the present invention, the system further includes a gateway to facilitate wireless access to the middleware layer from a client device leveraging existing wireless networks. In an aspect of the present invention, the system further includes a load balancer for balancing loads between the client device and the middleware layer.

The method includes the steps of accessing stored data, providing a course of action using the accessed data, and remotely accessing the provided course of action. The step of providing a course of action further includes the steps of generating, updating, or firing fuzzy logic rules and manipulating the stored data using fuzzy logic inference guided by the fuzzy logic rules.

By generating fuzzy rules for capturing expert knowledge, one can later update these rules based on feedback from the system. As well, the rules can be updated without having to change the inference engine programming code. By using hand-held devices, the invention provides mobile data management for medical care units. The invention provides efficiency in patient treatment, cost efficiency, paper-work reduction, resource allocation and utilization management, error minimization, clinical research, and data mining.

By providing an intelligent system capable of assisting in accurate diagnosis and treatment, the invention provides timely information through the use of a wireless hand-held device to cost-effectively deliver global accessibility to patient records. The invention provides near real-time information to aid in making clinical decisions, and streamlines the clinical process to improve decision-making quality. The invention facilitates medical procedures, speeds up processing times, and eliminates paper-related errors.

Other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

Brief Description of the Drawings

These and other features, aspects, and advantages of the present invention will become better understood with regard to the following description, appended claims, and accompanying drawings where:

Figure 1 is an overview of an intelligent data management system in accordance with the present invention;

Figure 2 is an overview of an intelligent data management method in accordance with the present invention;

Figure 3 illustrates an overview of a wireless architecture in accordance with a preferred embodiment of the present invention;

Figure 4 illustrates a fuzzy inference engine structure flowchart; and

Figure 5 illustrates a fuzzy knowledge base structure flowchart.

Detailed Description of the Presently Preferred Embodiment

The present invention is directed to an intelligent data management system and method. As illustrated in Figure 1, the system 10 includes a database 12 of stored data 14, a middleware layer 16 having access to the stored data 14, and at least one client device 18 for remotely accessing a provided course of action 20. The middleware layer 16 includes a fuzzy logic knowledge base 22 for generating, updating, or firing fuzzy logic rules 24 and a fuzzy logic inference engine 26 for processing the stored data 14 guided by the fuzzy logic rules 24 to provide the course of action 20.

In an embodiment of the present invention, as illustrated in Figure 3, the system 10 further includes a gateway 28 to facilitate wireless access to the middleware layer 16 from a client device 18 leveraging existing wireless networks. In an embodiment of the present invention, the system 10 further includes a load balancer 30 for balancing loads between the client device 18 and the middleware layer 16.

As illustrated in Figure 2, the method 100 includes the steps of accessing stored data 102, providing a course of action using the accessed data 104, and remotely accessing the provided course of action 106. The step of providing a course of action 104 further includes the steps of generating, updating, or firing fuzzy logic rules 108 and manipulating the stored data using fuzzy logic inference guided by the fuzzy logic rules 110.

The following described embodiments are directed to medical record management embodiments of the present invention, provided as exemplary examples of the present invention. Although what is described herein is directed to medical record management embodiments, it should be noted that other embodiments are contemplated and envisioned such as, but not limited to, materiel handling systems, transportation systems, and governmental services.

The system 10 is provided in a flexible object model to provide analysis and design of patient charts, as well as billing and scheduling capabilities. The database 12 is a patient-based design with data 14 categorized and stored based on its importance in diagnosis. An object-oriented analysis provides an effective approach for communicating with the application and domain expert.

As illustrated in Figure 4, the fuzzy logic inference engine 26 provides the decision-making. The fuzzy logic inference engine 26 has been designed and implemented for medical diagnosis purposes. However, since the engine is modular, it can be restructured for other uses. As illustrated in Figure 5, the invention leverages expert knowledge to create a knowledge base 22 and fuzzy logic rules 24 to capture this knowledge and be available for process by the independent fuzzy inference engine 26. By creating a modular inference engine 26 that is separate from the knowledge base 22, updating the diagnosis and treatment rules 24 is made to be easier. The modular inference engine 26 is parameterized with various indices that would help cover a wide variety of inference mechanisms between the Mamdani and Formal Logical extremes. The crisp diagnosis is computed through a parameterized defuzzification method. Finally, parametric norms are used for rule firing using information obtained from the fuzzy rules 14. The parameterized inference engine 26 provides the flexibility to adapt to one of many possible methods of reasoning, some of which can be better than others in the diagnosis of a specific disease within a medical discipline.

The inference engine 26, as a class entitled "InferenceEngine", has been designed to include the database 12 and procedures required for

diagnosis, cause and treatment of medical conditions. The class retrieves patient information from the database 12 through GetFactor functions, and launches a fuzzy logic procedure for diagnosis. The system provides guidance for experts on how to structure their knowledge for rule generation. As illustrated in Table 1, the fuzzy logic inference engine is modular with multiple operators.

TABLE 1: Fuzzy Logic Inference Engine Operators

Fuzzy numbers:	
Creat	Create a fuzzy number in two steps
GetFiredHeight	Find the height of a fuzzy number to the effect of an event
GetMin	Find the minimum range of a fuzzy number
GetMax	Find the maximum range of a fuzzy number
GetArea	Find the area of a fuzzy number
Rule Base:	
SNorm	Obtain the summation of all fired fuzzy numbers
TNorm	Find the interaction of the fuzzy numbers
Defuzzify	A generic defuzzification method that uses a parameter to determine the defuzzification method used
DoProcess	Perform the diagnosis process
Inference	Perform the fuzzy inference
GetDrawPoint	Only for displaying the result

Knowledge structuring can include a list of diagnosis and/or lab tests, family histories, medical examinations, as well as medical procedures related to diagnosis. In addition, knowledge structuring can further include defining relationships, logical expression of relationships, choosing keywords for processing, prioritizing of all related parameters to diagnosis, sensitivity analyzing, and classifying parameters.

Handling numeric and linguistic inputs. A rule base is constructed to provide a suitable course of action 20 through "defuzzification", with a non-zero output membership area. An object-oriented approach was used in designing the database 12 structure. The database 12 gathers patient related data 14 and stores it in several main categories such as: Personal Information, Lab Test, Diagnostic Imaging, Report, Medical History Physical Examination, Surgical Pathology and Diagnosis categories.

In an embodiment of the present invention, data 14 from a patient's medical records can be utilized by a billing system to better automate the system and to provide cost savings through the elimination of data entry overlap. In a preferred embodiment of the present invention, the system is implemented at least in part as a wireless solution. While the system can be run from standalone computer platforms, the invention is advantageously utilized within a wireless network environment to take advantage of the power and flexibility inherent within the system. Medical personnel can then carry hand-held devices that enable them real time access to a patient's medical records instead of the limited and cumbersome traditional methods of carrying paper folders, clipboards, and the like.

Figure 3 illustrates a wireless architecture overview in accordance with a preferred embodiment of the present invention. The system provides a flexible architecture designed to support wireless hand-held devices. All information relating to patients can be stored on a server with a hand-held device used to retrieve the information from the server leveraging the wireless infrastructure. Multiple wireless access points can be provided to ensure connectivity throughout an entire medical unit. All diagnostic images, prescriptions, laboratory results and treatment information are stored on a server and can be retrieved through the hand-held device.

In general, the architecture is divided into 3 layers, the client layer 18, the middleware layer 16, and the data layer 12. The client layer 18 can be an application client, web client, or wireless handheld device. The middleware

layer 16 contains all business rules, business objects and entities, and any supporting services such as security, report, and query. Thirdly, the data layer 12 is where all the data 14 is stored, and normally where the database 12 resides. With this flexible architecture, the system can support wireless applications with less effort because all rules, entities, and services are in the middleware layer 16, and the database 12 can be reused and therefore developers need only concentrate on developing communications between the wireless handheld device 18 and middleware layer 16, presenting information to the handheld devices, and supporting databases in handheld devices.

The system's architecture includes a wireless client, such as a smart phone, handheld devices, pocket PC, and the like, that communicates through a wireless network such as CDMA (Code Division Multiple Access), CDPD (Cellular Digital Packet Data) or GSM (Global System for Mobile communication) to a gateway. The gateway then communicates with the middleware layer 16 through TCP/IP. The middleware layer 16 then manipulates the data 14 in the data 14 layer and communicates with any legacy systems using protocols such as JDBC (Java Data Base Connectivity), JMS (Java Messaging Services), XML (eXtensible Markup Language), and HTTP (Hyper Text Transfer Protocol). The invention's wireless architecture is capable of handling a variety of wireless communications such as batch transfers from server to hand-held device, real-time transfers from server to hand-held device, and real-time transfers between hand-held devices.

Because the system uses the standard XML (Extensive Markup Language) or other similarly flexible markup to exchange and structure information, it can support both wired clients and wireless clients. By using XML language, the system can use the XSL (Extensible Stylesheet Language) to transform the data 14 into different formats or different presentations. For example, if a web client makes a request using the HTTP protocol, then the system will transform the XML into HTML (Hyper Text Markup Language) using XSL before responding to the client. However, if a wireless handheld device makes a request using the WAP protocol, then the

system will transform the XML into WML (Wireless Markup Language) using XSL before passing the response back to the client. Such a flexible architecture is needed in order to handle different types of wireless handheld devices using different markup languages for content delivery. The application server can readily be used as a wireless application server. The system can support Java clients, web clients, and/or wireless clients.

The system architecture is based on J2EE (Java 2 Enterprise Edition) technology; a widely adopted technology for building enterprise applications. Since the invention is based on a flexible architecture technology, it can be deployed on virtually any platform. J2EE technology includes elements such as EJB (Enterprise Java Bean(s)), JSP (Java Server Pages)/Servlet, JDBC, JMS, Java mail, and JNDI (Java Naming and Directory Interface). The application server can be used as a wireless application server. As mentioned previously, XML is used for information exchange and for structuring information. As for the client, the system can support java clients, web clients, and/or wireless clients.

The system can support wireless applications including wireless web, lightweight database, and thin client/server applications. The wireless web technology is a browser technology. For this type of wireless application, the system supports WML/WAP. The system architecture makes it flexible enough to support all major mark-up languages for wireless devices.

In this architecture, the client is used only for presenting information. All business logic resides in the middleware layer 16. The middleware layer 16 includes the application server 161, business process 162, business entities 163, application services 164, business intelligence module 165, and request processor 166. The application server 161 manages transactions, resources, and persistent data 14. The business process 162 is where all the business rules and logics reside. Its purpose is to process the information within the business objects. A business object encapsulates the business information. The advantage of separating the business processes 162 from business objects is that business objects are reusable entities that can be reused within

other applications. Another advantage is derived from the fact that business objects are seldom changed, but business rules and processes are constantly changing.

The application services 164 are services that support the business such as security service, query service, report service, and messaging service. The business intelligence module 165 is an artificial intelligence module that assists a physician or hospital in providing patient healthcare. The request processor module 166 processes requests from the client and presents information to the client. The data layer 12 includes the databases 12 where all data 14 is stored, and can include legacy systems 121.

Wireless devices can be supported with modules such as "scheduler", "view/transfer patient chart", and "order entry" modules. The scheduler is generic and flexible, and since it is 'intelligent' it can automatically make appointments based on the resources available and the needs of a specific situation. Appointment parameters include date, time, people to meet, and/or equipment required and procedures to be performed, as well as the space required for these procedures. In order for these to take place in an orderly fashion, all parameters need to be scheduled to come together at a pre-selected date and timeslot for a particular appointment. In addition, the scheduler should be capable of re-adjustment if and when an appointment has to be changed. The purpose of the scheduler is to make the most efficient use of the aforementioned parameters for the appointments for which they are required. To ensure that the scheduler is generic and flexible, it has been designed to treat all appointment parameters as resources. Therefore, the scheduler can be used in other applications. For medical applications, resources include the patient, provider, equipment, location, and the like.

The scheduler includes an AI engine that learns how a particular provider utilizes appointment times for different types of appointments, so that the scheduler is able to suggest an appropriate duration for appointments of different types and/or differing providers. The scheduler's 'learned intelligence'

is capable of suggesting the earliest available time slot for an appointment based on the type of appointment and resources required.

The scheduler's AI engine facilitates efficient use of resources for various appointments that are required, without sacrificing the need for prioritizing appointments based on the urgency of the matter. For example, one appointment might require three resources with an appointment duration of one hour. However, the third resource may only be required ten minutes after the start of the appointment, and for just twenty minutes. The scheduler can then make that resource available for other appointments where it is required, making efficient use of that resource.

The scheduler is user-customizable, since it's design is based on a template and dictionary, or knowledge base. A user can create different types of appointments with different types of resources. In addition, the user can pre-assign resources specifically required for a particular appointment as a default value in the template, such as when a specific surgeon is required or requested by the patient. Therefore, complicated appointments having 'fixed resources' as default values and other resources as variables ones, and that depend on multiple resources can be made in near real time, which when done in the traditional manner could take a day or more.

The scheduler can handle highly sophisticated and complex appointment schedules. One of the most complex appointments is when a main appointment depends upon several additional appointments. For example, a surgical appointment might require the patient to have a physical, X-ray, and the like before the surgical procedure can be performed.

The view/transfer patient chart module can include: patient information, patient history; patient problem list, patient treatments, and patient diagnostic results such as X-Ray, MRI, and laboratory results. The order entry module can include laboratory requisitions, prescriptions, and diagnostic procedures. Examples of patient record management tasks include the creation, editing, and updating of patient records, retrieving pertinent information and

manipulating diagnostic images. Image handling can include rotation, side-by-side and overlapping comparison.

Included thin client/server technology enables communication between the handheld device 18 and the middleware layer 16. The handheld 18 device can then make use of the services provided by the middleware layer 16. With this technology, the client software is installed on the handheld device 18. However, different handheld devices 18 have different platforms. Therefore, to avoid having to write client programs for every platform, it would be preferable that the client programming be written using J2ME (Java 2 Micro Edition), a lightweight version of Java technology, or other similarly lightweight language that targets small devices. Because J2ME is Java technology, it resolves the problem of security since the code can be downloaded, is platform independent, and provides full-color graphics and robust applications. In addition, the user can enjoy full color graphics and can manipulate diagnostic images on the hand-held device, such as manipulating an X-ray image.

The use of lightweight databases on handheld devices 18 is desirable within healthcare applications where there is often a need to work offline either due to cost-saving reasons, or for use in locations where there is no network coverage. With this technology, the user is able to store information locally on the handheld device 18 using a JDBC interface. Any changes are then synchronized with the master database over a wireless connection when network access becomes available. Another use for a lightweight database is for preloading static information such as drug formulary, making it possible for physicians to prepare prescriptions on the hand-held device 18 before sending them to a pharmacy.

The invention provides an artificial intelligence engine 165 with an intelligent graphical web browser interface that facilitates decision-making in diagnosis and treatment. The mobile wireless technology facilitates the use of hand-held devices 18 to access patient information from a central pool. By applying an intelligent graphical web browser interface that can be applied to a database 12 of electronic medical records, critical information can be

reviewed before decision-making. This will not only expedite processing time, but will ultimately eliminate paperwork and its associated errors.

As well, the system incorporates elements that ensure compliance with privacy regulations and confidentiality requirements. The invention provides global accessibility through the use of an electronic medical record via the centralized storage of patient records including diagnostic images. In exemplary embodiments of the present invention, the system can further include a flexible billing system that meets the diverse requirements of a variety of providers, as well as a laboratory central pool, a pharmacy central pool, and/or a material central pool.

By generating fuzzy rules 24 for capturing expert knowledge, one can later update these rules 24 based on feed back from the system. As well, the rules 24 can be updated without having to change the inference engine 26 programming code. By using hand-held devices 18, the invention provides mobile data management for medical care units. The invention provides efficiency in patient treatment, cost efficiency, paper reduction, resource allocation and utilization management, error minimization, clinical research, and data 14 mining.

By providing an intelligent system capable of assisting in accurate diagnosis and treatment, the invention provides timely information through the use of a wireless hand-held device 18 to cost-effectively deliver global accessibility to patient records. The invention provides near real-time information to aid in making clinical decisions, and streamlines the clinical process to improve decision-making quality. The invention facilitates medical procedures, speeds up processing times, and eliminates paper-related errors.

Although the present invention has been described in considerable detail with reference to certain preferred embodiments thereof, other versions are possible. Therefore, the spirit and scope of the appended claims should not be limited to the description of the preferred embodiments contained herein.

What is claimed is:

1. An intelligent data management system comprising:
   a database of stored data;
   a middleware layer having access to the stored data, the middleware layer including:
      a fuzzy logic knowledge base for generating, updating, or firing fuzzy logic rules; and
      a fuzzy logic inference engine for processing the stored data guided by the fuzzy logic rules to provide a course of action; and
   at least one client device for remotely accessing the provided course of action.

2. The system according to claim 1, further including a gateway to facilitate wireless access to the middleware layer from a client device leveraging existing wireless networks.

3. The system according to claim 1, further including a load balancer for balancing loads between client devices and the middleware layer.

4. An intelligent data management method comprising the steps of:
   (i) accessing stored data;
   (ii) providing a course of action using the accessed data by:
      a) generating, updating, or firing fuzzy logic rules; and
      b) manipulating the stored data using fuzzy logic inference guided by the fuzzy logic rules; and
   (iii) remotely accessing the provided course of action.

5. An intelligent data management system comprising:
   means for accessing stored data;
   means for providing a course of action using the accessed data by:
      means for generating, updating, or firing fuzzy logic rules; and
      means for manipulating the stored data using fuzzy logic inference guided by the fuzzy logic rules; and

means for remotely accessing the provided course of action.

6. A storage medium readable by a computer encoding a computer process to provide an intelligent data management method, the computer process comprising:

a processing portion for accessing stored data;

a processing portion for providing a course of action using the accessed data by:

a processing portion for generating, updating, or firing fuzzy logic rules; and

a processing portion for manipulating the stored data using fuzzy logic inference guided by the fuzzy logic rules; and

a processing portion for remotely accessing the provided course of action.

7. An intelligent data management system substantially as herein described and/or shown in the drawings.

8. An intelligent data management method substantially as herein described and/or shown in the drawings.

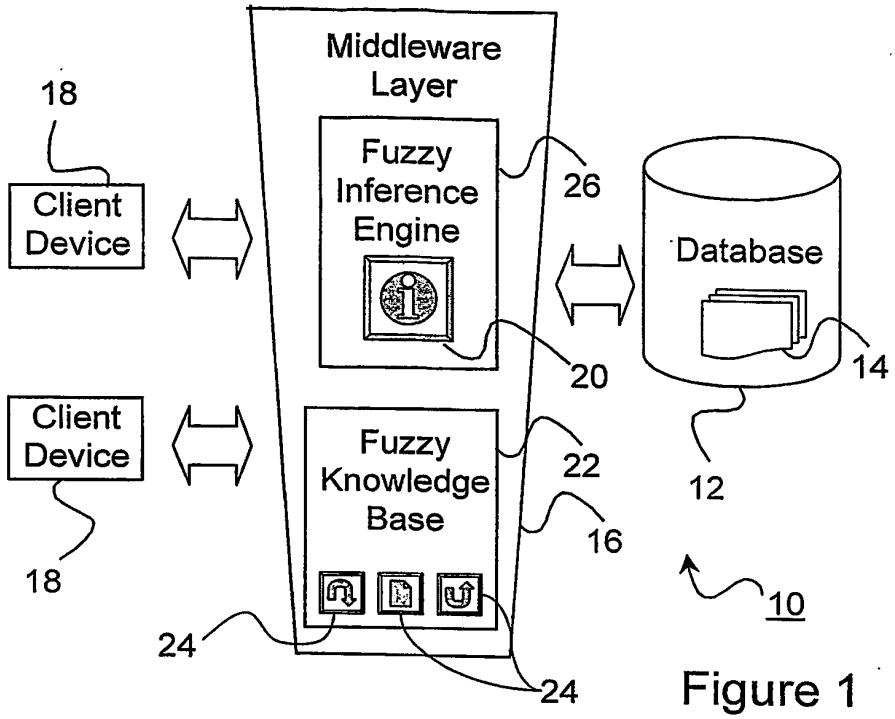

Figure 1

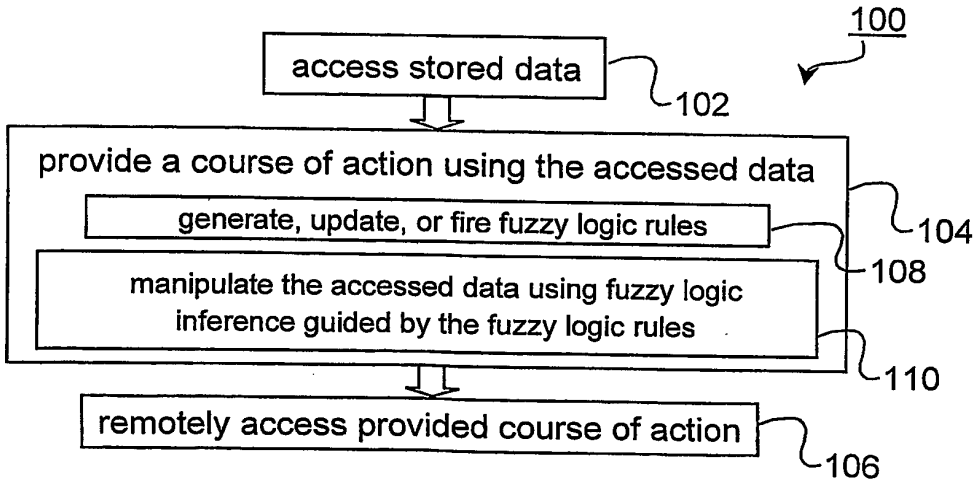

Figure 2

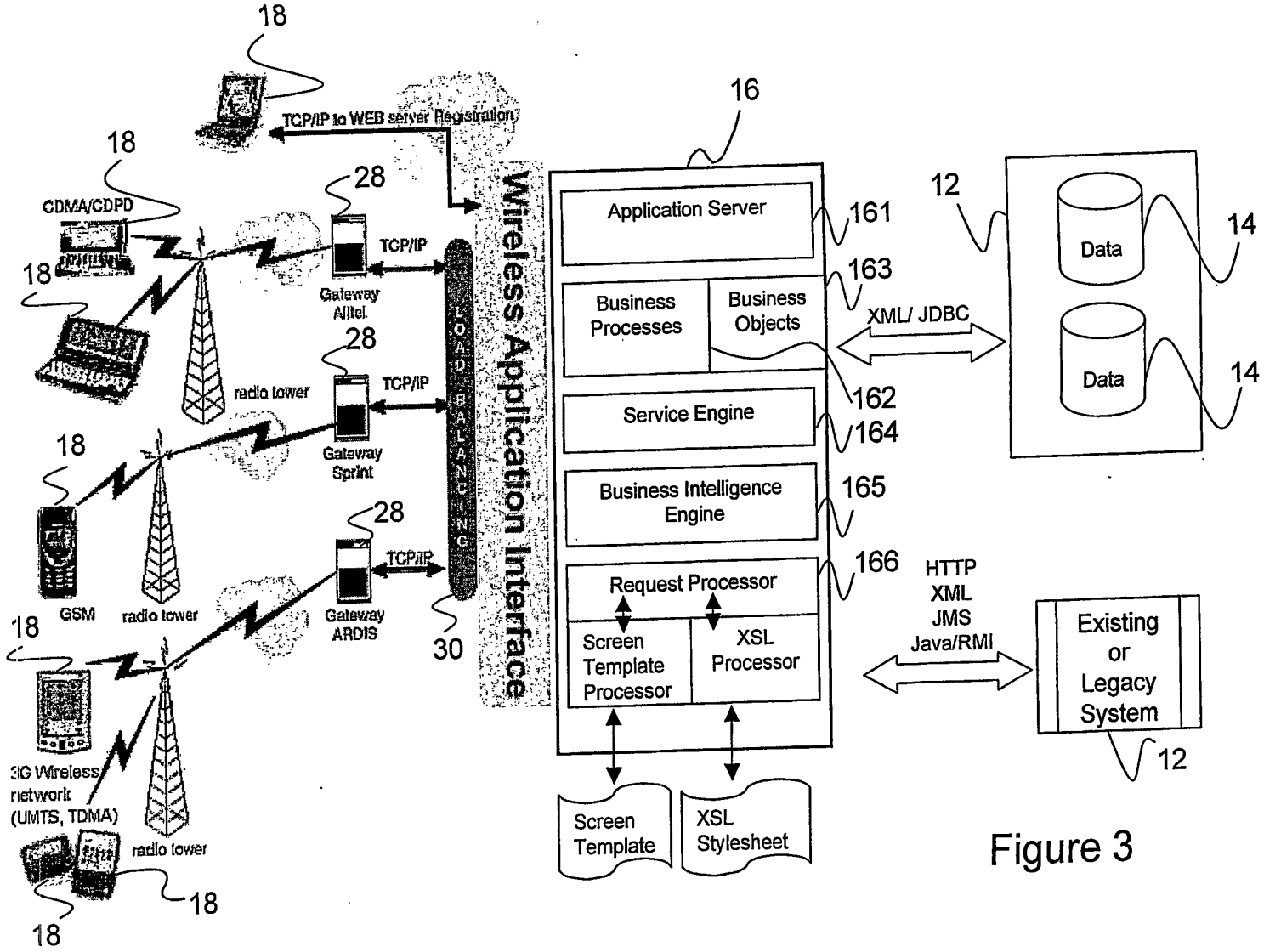

Figure 3

Gowling Lafleur Henderson LLP

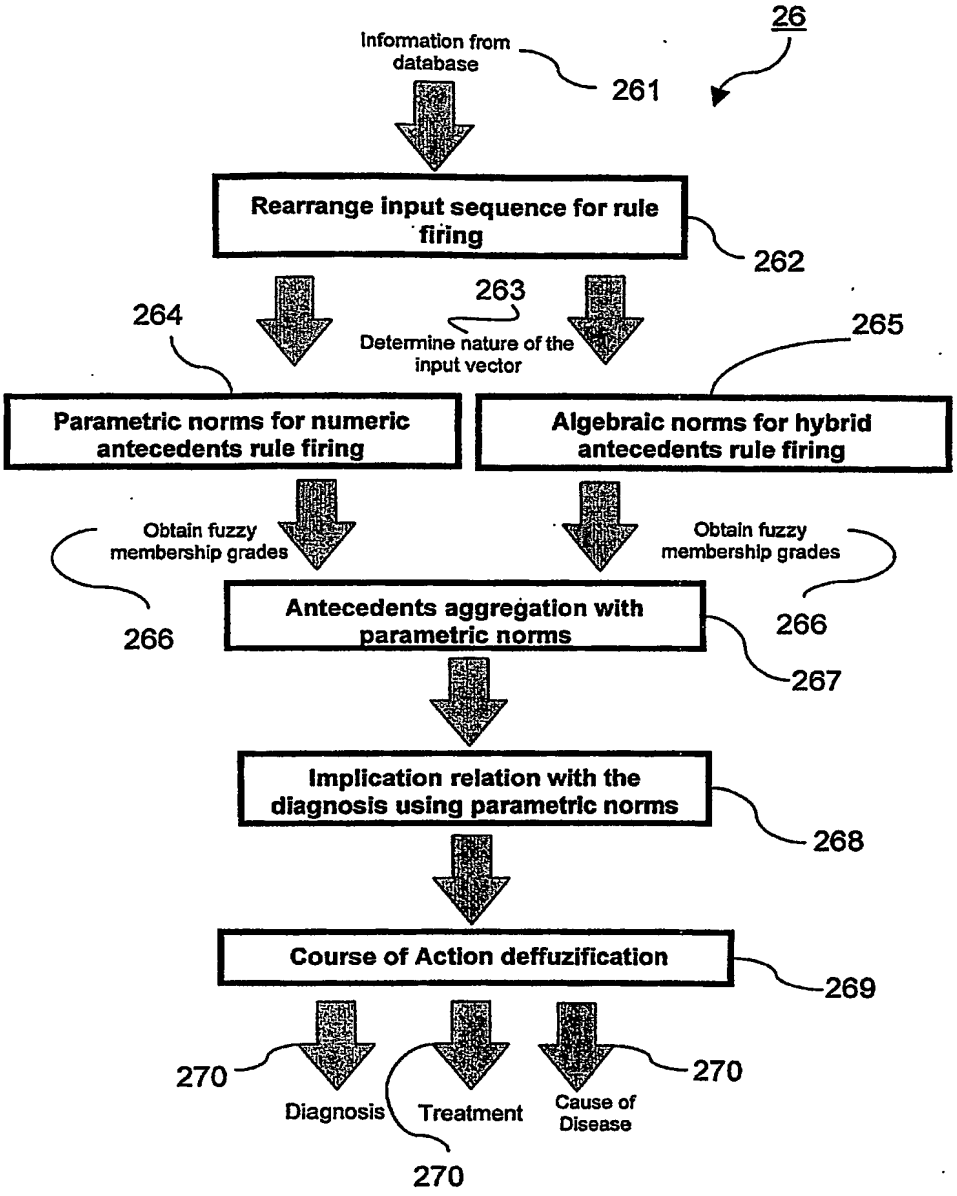
26
Information from database
261
Rearrange input sequence for rule firing
262
263
264
Determine nature of the input vector
265
Parametric norms for numeric antecedents rule firing
Algebraic norms for hybrid antecedents rule firing
Obtain fuzzy membership grades
Obtain fuzzy membership grades
266
266
Antecedents aggregation with parametric norms
267
Implication relation with the diagnosis using parametric norms
268
Course of Action deffuzification
269
270
270
Diagnosis
Treatment
Cause of Disease
270

Figure 4

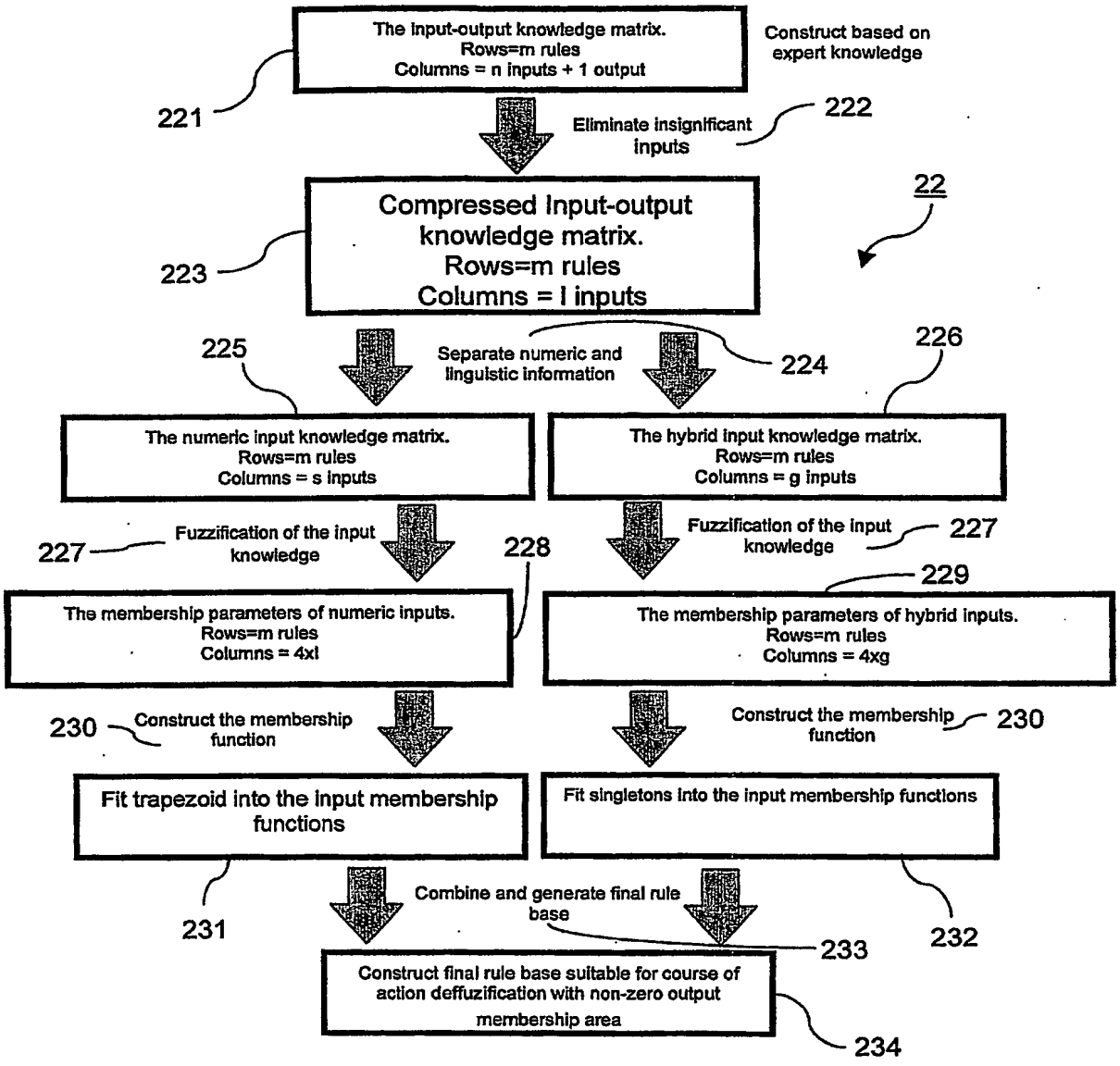
The input-output knowledge matrix.
Rows=m rules
Columns = n inputs + 1 output
Construct based on expert knowledge
221
Eliminate insignificant inputs
222
Compressed Input-output knowledge matrix.
Rows=m rules
Columns = l inputs
22
223
225
Separate numeric and linguistic information
224
226
The numeric input knowledge matrix.
Rows=m rules
Columns = s inputs
The hybrid input knowledge matrix.
Rows=m rules
Columns = g inputs
227
Fuzzification of the input knowledge
228
Fuzzification of the input knowledge
227
229
The membership parameters of numeric inputs.
Rows=m rules
Columns = 4xl
The membership parameters of hybrid inputs.
Rows=m rules
Columns = 4xg
230
Construct the membership function
Construct the membership function
230
Fit trapezoid into the input membership functions
Fit singletons into the input membership functions
231
Combine and generate final rule base
232
233
Construct final rule base suitable for course of action deffuzification with non-zero output membership area
234

Figure 5